Boulder, Colorado, March 24, 1920 (*Elery R. Becker*).

Visits flowers of *Townsendia exscapa* (Rich.), which is the first spring flower in the locality. This might be taken for *A. nasoni*, var. *fulvodorsata*, Viereck, but the clypeus is quite different, and the wings are differently coloured. On account of the red hair on scutellum, it resembles *A. scutellaris*, Rob., but that has first r.n. joining the oblique second s.m. far beyond middle, much weaker abdominal bands, &c.

Bombomelecta semifulva, sp. n.

♂.—Length about 14·5 mm., anterior wing 10·5 mm.

Black, somewhat elongate, the thorax above and first abdominal segment densely clothed with fulvous hair; head very broad, with prominent eyes, and projecting clypeus; hair of head a peculiar sooty grey, partly reddish on clypeus, thick and black on outer side of scape, long and broadly tipped with black on upper part of cheeks behind; third antennal joint a little longer than fourth; sides and venter of thorax with mouse-coloured hair, very broadly tipped with black on mesopleura; metathorax with similar, largely black, hair; scutellum with the usual spines, hidden by hair; tegulæ black. Wings stained with brown, but not dark. Legs with mouse-coloured hair, black on inner side of tarsi. Abdomen beyond first segment with appressed greyish-brown hair, mixed with longer black hair, which becomes more abundant on the apical half; no trace of bands or spots.

Boulder, Colorado, May 17, 1920 (*Elery R. Becker*).

A very distinct species, perhaps nearest to *B. pacifica* (Cress.), but readily known by the hair on abdomen.

XXVI.—*A Preliminary Study of the Structure and Function of the Cutaneous Glands in the Terrestrial Isopoda.* By Walter E. Collinge, D.Sc., F.L.S., The University, St. Andrews.

[Plates II. & III.]

Introduction.

It has frequently been pointed out by investigators upon the minute anatomy of the Terrestrial Isopoda, how numerous are the difficulties that are presented in connection with the preservation and preparation of the different organs for histological investigation. Huet (3) has very truly stated that

one is obliged to create a particular technique in such work, for what succeeds in the case of other invertebrates—indeed, in one group of crustaceans—fails to give results.

In working at the general anatomy of the Terrestrial Isopoda, I have been compelled to make numerous experiments with various media. Many have proved ineffectual, but a few have given excellent results, thus enabling one to progress beyond the point reached by previous workers. The peculiar caudal or cutaneous glands are a case in point, and form the subject of the present paper. Hitherto their structure and distribution has remained only partially known owing to imperfect or faulty methods of preparation.

These bodies are now described and figured in detail for a single species, viz., *Porcellio dilatatus*, Brandt, but practically all the British species of woodlice have been examined and partly worked out. At a later date I hope to give full details and figures of the distribution and histological structure of these glands in a large number of genera and species, together with some remarks upon their morphological significance—the present paper being merely a preliminary study, as expressed in its title.

Historical Review.

The structures which form the subject of this paper were first described by Lereboullet in 1850 (5), who writes :—" Up to the present no one has described the special organ of secretion in the woodlice. One knows, however, that these crustacea, principally the Porcellios, allow a flowing matter to escape from their caudal appendages, which recalls the silk of a spider, although much less consistent.

" Quite often, in touching the extremity of an appendage with the finger, one succeeds in drawing off a thread of two or three centimetres length and upwards ; as soon as it breaks it floats in the air like an exceedingly fine spiders' web.

" I have discovered the organs which are the seat of this secretion. They are small compound glands situated at the origin of the first articulation of the caudal appendages, in the most posterior part of the abdominal cavity on the sides of the rectum."

After briefly describing his method of preparation, this author continues :—" These glands, numbering from four to six on each side, measure on an average ·30 mm., they are composed of a variable number (about a score) of transparent vesicles of irregularly conical form; the contracted portions

of which converge towards the central part of the gland, giving this last the aspect of a little rosette. Each of the composing vesicles is finely granulated, an appearance which without doubt is due to the epithelium covering it internally ; their diameter varies greatly, the largest measuring at their base ·75 mm. Several times I have seen a rather fine tube become detached from the glandular mass ; this tube is, without doubt, an excretory canal ; but I am ignorant as to how these very fine canals behave in the interior of the appendage. In the middle of each gland one or two opaque bodies can be seen, which have the appearance of granular nuclei. These bodies, ordinarily double or triple, are, I believe, rudimentary vesicles, which will subsequently develop and will become similar to the other vesicles. This, I think, must be their *rôle* there, since one almost always sees around them transparent but much smaller vesicles than the others.

"I have verified the existence of these glandular bodies in the genera of woodlice *Porcellio* and *Armadillidium*. No doubt but that they are the seat of the viscous secretion produced by these animals, for they themselves are very viscous, and their adherence to the needles or to the neighbouring parts, is one of the difficulties of their preparation.

"The presence of these excretory organs is an interesting fact with regard to the bearing of zoological affinites. One knows that the silk of spiders is due to numerous vesicles contained in the abdomen: the matter secreted by these vesicles issues by the spinnerets and presents scarcely any greater consistency at the moment of issue than the flowing matter of the woodlice. But in the spider the viscous substance coming out by the numerous holes of the sieve which terminates each spinneret, finishes by forming a rough tough thread, while in the woodlice, this matter issues by a single orifice."

Lereboullet's description is very imperfect. His reference to the number of the glands as being four to six probably refers to the number of groups. He evidently observed the three nuclei, but was wrong in supposing that each would become a separate vesicle, and that the glands were compound. Further, the entire absence of any reference to these glands in the mesosome would seem to indicate that he observed them only in the metasome.

Max Weber (9) in 1881 published his researches on the Trichoniscidæ, in which memoir he points out that in addition to the occurrence of these glands, which he rightly

regarded as unicellular bodies, in the metasome, he found them in the 5th, 6th, and 7th segments of the mesosome in the Trichoniscidæ, *Ligidium*, *Philoscia*, and *Porcellio pictus*. He speaks of the excretory canals as one joining the other before opening externally, whilst others terminate by an aborization of slits or "Spatten."

Still later, Huet (2 & 3) studied the structure of these bodies. His account differs in many details from both that of Lereboullet and Max Weber. The full details were set forth in 1883.

According to this author the glands are not compound, but agglomerated unicellular glands ; they are lobed, and each contains two nuclei. Between the two nuclei he describes a hollow cavity or vestibule, from which the excretory canal proceeds. The canals never join one another, each opening by a separate pore.

Like Max Weber, Huet observed the glands in the mesosome as well as in the metasome *. In *Porcellio lævis*, he states that they are present in all the segments of the mesosome and metasome, the former having peculiar sieve-like openings "on the superior face of the epimeres, quite close to their edge. . . . The number of openings in each sieve indicates the number of glands occupying each epimere. It is about 30 to 35 in *Porcellio lævis*." The glands of the metasome open in a groove on the external side of the external articulation of the uropods, the openings being arranged in linear series.

In *P. scaber* they are described as being similar, but in addition the glands of the last three metasomatic segments have proper openings, but these are not present on segments 1 and 2, which are partly covered by the posterior portion of the mesosome. They are present in the telson, he states, and open as usual on the uropods.

In *P. frontalis* (=*Porcellionides pruinosus*, Brandt) he states that they only occur in the metasome and telson, and all open on the uropods. The same condition obtains in *Oniscus* and *Armadillidium*, according to Huet.

In *Ligia oceanica*, the Marine Isopoda, and in *Asellus aquaticus* they are stated to be absent, and not present in the embryo or newly hatched isopod.

* On p. 365, Huet draws attention to the fact that Max Weber had pointed them out "not only in the metasome, but also in the 5th, 6th, and 7th segments of the thorax or mesosome in the Trichoniscidæ, then in *Ligidium*, *Philoscia*, and *Porcellio pictus*," but on p. 370 (*op. cit.*) he says "Max Weber, who has only seen them on the posterior segments of the body," etc.

They are derived from the conjunctive tissue.

Nebeski (7) in 1880 pointed out that there were light and dark coloured cells among the species he studied, and Ide confirmed this, suggesting that the larger the cells are, the more the division into two zones is accentuated.

In 1891 (4) Ide briefly described these glands in *Oniscus asellus*; he states "that they are present in the uropoda and the last three abdominal segments, the canals of which are all directed towards the cuticle of the uropoda. The urostyle (=the expodite) is entirely filled with these glands and a series are situated by the side of the intestine. Each gland opens separately and their orifices are disposed in two or three rows."

There are four nuclei, he states, in each cell. Two, seen by Huet, containing large nucleoli and a network not very rich in nuclein, are lodged in the secreting mass itself. The third nucleus is small and oval; it is found almost between the two first on a level with the union of the excretory canal with the principal mass. A fourth nucleus is constantly met with on the excretory canal itself. It is extremely flattened and scarcely surrounded by a thin protoplasmic layer.

There is considerable variety in the form of the glandular cells, and there is no vestible in the cells as described by Huet. The glands produce a viscous material, which takes the form of very tenuous but rather resistant filaments.

It will be noticed that Ide makes no mention of any glands in the mesosome.

Finally, in 1907, Verhoeff (8) very briefly pointed out the distribution of these glands in numerous genera, and endeavoured to utilize the position of the pores for systematic purposes. In spite of the very brief and fragmentary descriptions given by this author, he was the first to reconize the true segmental nature of the cutaneous glands, and regarded it as a primitive feature in the organization of the Isopoda.

Their Occurrence in the Oniscoidea.

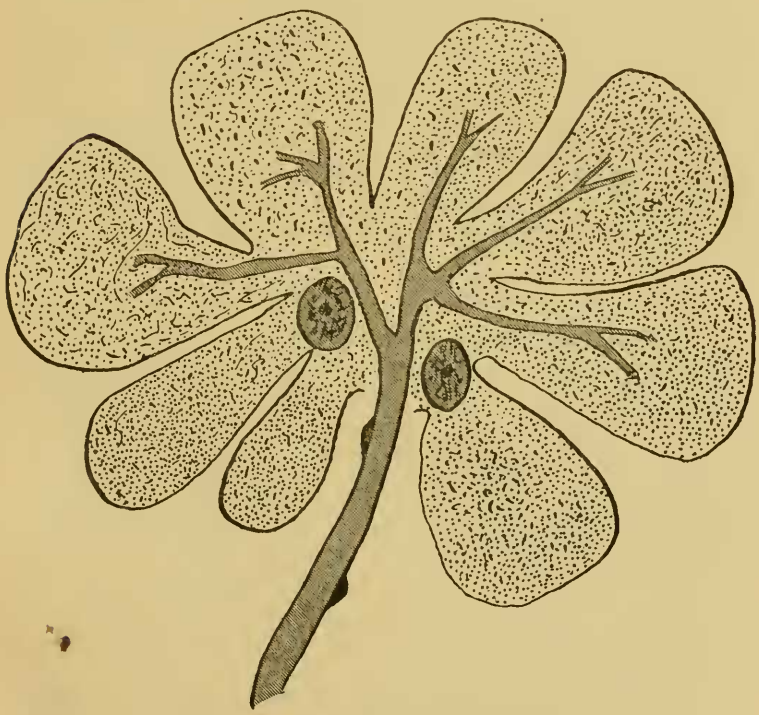
To what extent these glands occur in the Oniscoidea it is at present difficult to say. I have satisfied myself of their presence in the following British genera:—*Ligidium*, *Trichoniscus*, *Oniscus*, *Philoscia*, *Porcellio*, *Porcellionides*, *Cylisticus*, and *Armadillidium*. They are also present in *Cubaris*, *Hemilepistus*, and other exotic genera—indeed, I see no reason to doubt their presence in most, if not all, of the genera of this Order that are purely terrestrial in habit.

Structure in *Porcellio dilatatus*, Latr.

For the purpose of a preliminary study of the distribution and histological structure of these glands, the species *Porcellio dilatatus*, Latr., was chosen, although many other species have been examined ; but unless otherwise stated the following description and remarks apply to that species.

Apart from dissection, transverse, longitudinal, and horizontal sections have been made, and various methods

Fig. 1.



Typical appearance of a cutaneous gland and excretory canal in section.

adopted for the examination of the pleural plates of the segments. A modification of that described by me in 1918 (1) has given very satisfactory results.

In form the glands vary in size and shape according to their period of development, but a typical fully developed gland consists of a somewhat spherical mass with a series of

more or less conical or pyriform outgrowths. In section such bodies have the appearance shown in text-figure 1. Variations from this are described later.

In *P. dilatatus* these glands are distributed along the lateral portions of the mesosomatic segments, and open to the surface on the margins of the pleural plates. They occur in all the seven segments.

In the metasome six to ten glands were found on each side of the intestine in segments 4 and 5. In some sections traces of the glands appeared in segment 3, but I am not yet satisfied that these were naturally there. In the basipodite of the uropod 20 to 24 were counted and 12 and 15 in the expodite of this appendage. Each of these metasomatic glands has a separate and distinct canal, which opens on to the lateral surface of the basipodite or the expodite.

As already pointed out, the appearance of a gland varies when seen in section. When dissected out, all more or less assume the form of a rosette (Pl. II. fig. 2). In the above enumeration, only those glands are counted which have reached a stage beyond that shown in Pl. II. fig. 5.

Microscopic Description.

The minute structure of these bodies is best seen in the series of glands in the metasome, and, after examining a very large series of sections, the following cytological details have been made out.

Each gland arises as a very minute isolated cell (Pl. II. fig. 3), almost spherical in shape and containing protoplasmic contents that stain but lightly. These cells are easily identified and distinguished from other isolated cells by reason of their unusually large single nucleus, which contains a little nuclein. As the cells grow they assume a variety of shapes (Pl. II. fig. 4), all of which more or less exhibit indications of a partial division. Figure 5 (Pl. II.) shows a rather later stage in which there are two nuclei, and the three divisions are very marked, and also the commencement of the second and third nucleus. As I shall explain later, the nuclei here figured, although four in number, do not all correspond with those described by Ide.

In a much later stage (Pl. II. fig. 6) a section of a cell is shown in which the three nuclei have taken up their characteristic position, the fourth nucleus was not seen after the previous stage, and I conclude that either it disappears whilst still very small or fuses with one of the remaining three nuclei.

The gland-cell is now a typical rosette (Pl. II. fig. 2), and in section assumes a variety of shapes (Pl. II. fig. 7 & Pl. III. fig. 8).

I have nothing to add to the description of the protoplasm and nucleus of Ide, excepting that in those cells containing vacuoles these latter may be fairly small (Pl. III. fig. 9) or large spaces (Pl. III. fig. 10) filled with a non-granular secretion.

So far as my observations go, I am unable to agree with or corroborate Ide's account of the nuclei. His third nucleus may be the same as that here figured, but his fourth nucleus is, in my opinion, one of the nuclei of the excretory duct (Pl. III. fig. 12). In darkly stained specimens these can be seen from the commencement of the duct and traced at irregular intervals down to within a short distance of the external opening.

In neither *P. dilatatus* or *P. scaber* could any sieve-plates, as described by Huet, be found on the dorsal surface of the pleural plates. On the other hand, a very definite series of pores could be distinctly made out on the antero-lateral border of the pleural plates in both of the above-mentioned species (Pl. III. fig. 13), and the secretion could be drawn out, after being placed in dilute alcohol, in long thread-like strands.

It is exceedingly difficult to demonstrate these openings microscopically, but in pleura from which the under half had been removed, and then treated with formic acid, distinct pores could be clearly made out.

In the process of mounting and examining the pleural plates one frequently sees oval or circular areas having a sieve-like appearance, but these are due to physical causes, such as the mixing of a tiny drop of alcohol and xylol, the chemical action of acids, etc.

Pleural plates of various species were also treated by the hydrochloric acid and permanganate of soda method (1) and various other methods with similar results. I am therefore of opinion that the sieve-plates of Huet do not exist, but that there are cutaneous glands in the mesosomatic segments there cannot be the slightest doubt. In *P. dilatatus* these glands are repeated in each segment of the mesosome, and in segments 4 and 5 (possibly also in segment 3) of the metasome, and also in the uropoda.

Function.

Like many other glandular structures in the Crustacea,

it is exceedingly difficult to state what the true function of these glands is; their presence, however, in so many genera and species is at least indicative of their importance.

Max Weber (9) regarded them as in some way connected with the organs of respiration, but there is little or no evidence to support such a view.

Huet (3), whilst confessing that it was easier to state in what way they do not serve than to assign a function to them, suggests that possibly they are connected with the disagreeable odour which the Terrestrial Isopoda possess, and that added to this the secretion may have a disagreeable taste to enemies.

In *Porcellionides pruinosus* the secretion is, at times, very copious. A few living specimens were dropped into 90 per cent. alcohol and after a few minutes removed, when it was found that they were more or less bound together in a bundle by reason of the viscous strands of the secretion. The same result was obtained when specimens of *Porcellio dilatatus* were treated in a similar manner.

The former species exhibits in life a very beautiful "bloom" over the whole of the dorsal surface of the body, but whether it is in any way due to the secretion of the cutaneous glands we have no direct evidence. Four specimens of this species were taken and the "bloom" very carefully removed by wiping it off with a piece of soft silk, but on examining these specimens twenty-four hours later it was just as plentiful as on those specimens from which it had not been removed.

Careful experiments show that the secretion is more copiously extruded after the animal is disturbed. Specimens of *P. dilatatus* were confined to a small petri dish and frequent attempts made to pick them up with a pair of forceps. After chasing the specimens about for two or three minutes, one could, by holding a specimen in a pair of forceps, easily see large quantities of the secretion along the pleural plates of the mesosome and more particularly so on the metasome and the uropoda. There is no difficulty in drawing off strands of 15 to 30 mm. in length.

Attempts were made to collect some of the secretion, though unsuccessfully, but when it was drawn off by the fingers its peculiar and disagreeable odour was easily recognized, it being faintly discernible even after washing the hands.

From the above imperfect data I am inclined to agree with Huet that the function of these glands is to secrete a

viscous fluid, which has a disagreeable odour and which is probably protective.

Summary and Conclusion.

1. In this preliminary study we have satisfied ourselves that the Cutaneous Glands, first described by Lereboullet, are present in a large number of genera and species of Terrestrial Isopoda.

2. That they are glandular, segmentally arranged organs, differing slightly in position and number according to the genus or species.

3. In *Porcellio dilatatus* there are glands present in all the seven mesosomatic segments, which open to the surface by fine canals on the borders of the pleural plates. In the metasome they are present in segments (3 ?), 4, and 5 and in the uropoda.

4. In all cases they are agglomerated unicellular bodies with three nuclei, and lead into fine excretory canals which open on to the surface of the body.

5. The early stages and development are here described for the first time.

6. They are probably protective in function.

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EXPLANATION OF THE PLATES.

Plate II.

Fig. 1. Semi-diagrammatic figure of *Porcellio dilatatus*, indicating the regions of the metasome occupied by the cutaneous glands.
Fig. 2. Single isolated gland.
Figs. 3–6. Stages in the development of a gland.
Fig. 7. Typical section of a gland, showing nuclei.

Plate III.

Fig. 8. Typical section of a gland, showing the excretory tubuli and canal.
Figs. 9 & 10. Sections of glands containing vacuoles.
Fig. 11. Nucleus of a gland.
Fig. 12. Nuclei of the excretory canals.
Fig. 13. Terminal portion of a pleural plate, showing openings of canals.

XXVII.—*A Note on the Tail of* Spelerpes fuscus, *Bonaparte.*

By Joan B. Procter, F.Z.S.

In certain salamanders of the family Plethodontinæ the tail has been the subject of several interesting studies. Prehensibility, autotomy, structure of the dermis, and toxic secretions are all cited. For example:—Mr. Van Benburgh, in "Notes on the Habits and Distribution of *Autodax ïëcanus*"*, says, "The tail of this Autodax is prehensile. Several individuals, when held with the head down, coiled their tails around my finger, and, when the original hold was released, sustained themselves for some time by this means. . . . The animal's tail is also of use to it in another way. When caught, *Autodax ïëcanus* will often remain motionless, but if touched will either run a short distance with great speed, or, quickly raising its tail and striking it forcibly against the surface on which it rests, and accompanying this act with a quick motion of the hind limbs, will jump from four to six inches, rising as high as two or three."

Miss Hubbard, in her interesting paper "Correlated Protective Devices in some California Salamanders"†, has studied the autotomy, toxic secretions, and glandular thickening of the tail.

The tail of our European *Spelerpes fuscus* is only endowed with one of the above uses, prevalent among its American allies—prehensibility,—but it has also another function to perform.

* Proc. Cal. Acad. Sci. ser. 2, vol. v. (1895).
† Univ. Cal. Pub., Zool. vol. i. no. 4 (1903).